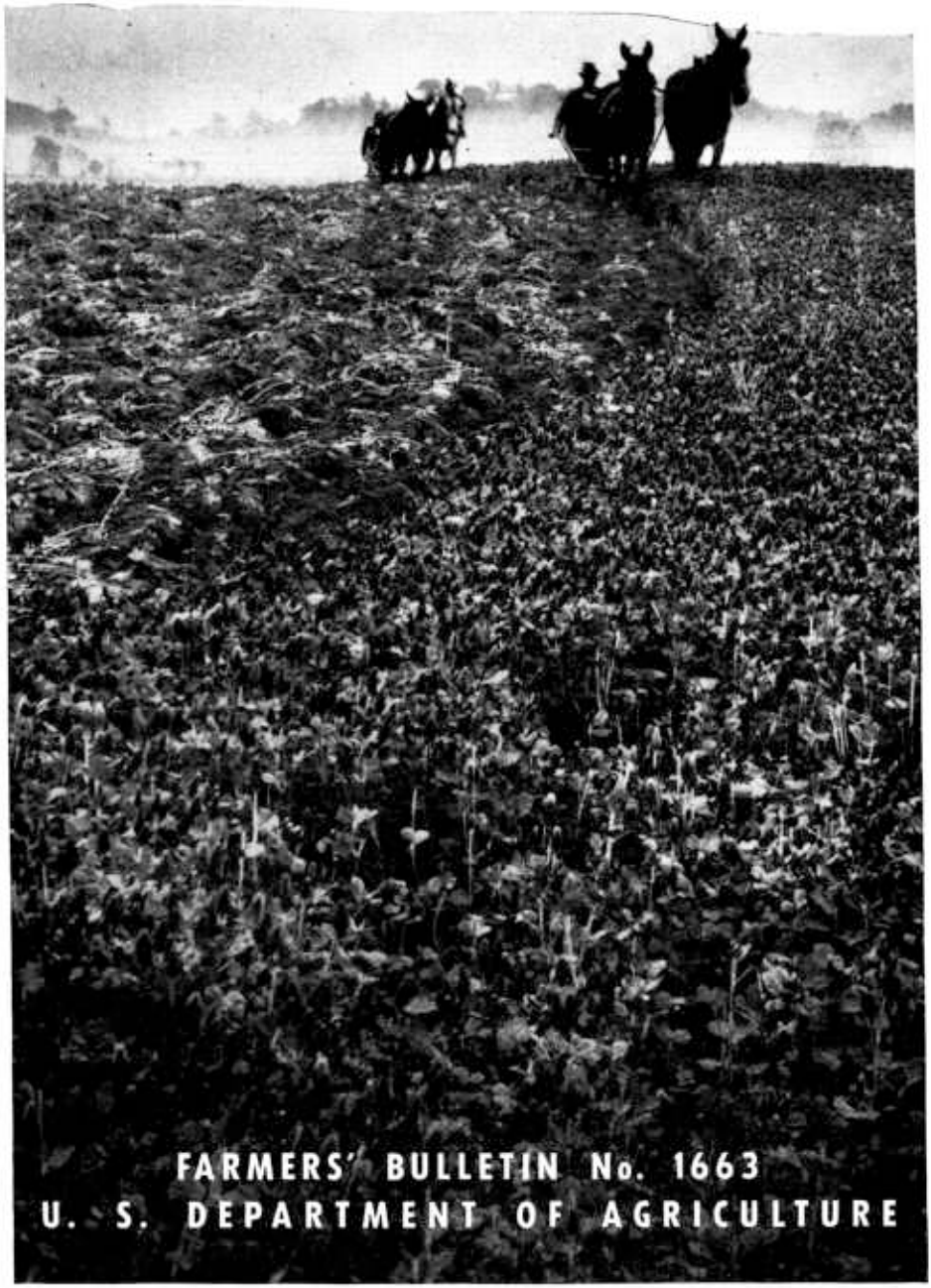
WINTER LEGUMES

FOR GREEN MANURE in the COTTON BELT



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THE increasing use of vetches, lupines, and other winter legumes for green manure in the Cotton Belt improves the physical condition of the soil, adds plant food, and increases the yields of subsequent crops grown in the rotation. It also reduces erosion and the leaching of plant nutrients.

Research has shown that the farmer should inoculate at the time of seeding and that he should use commercial fertilizer, largely superphosphate, especially when growing a legume crop on land for the first time. Barnyard manure also is a good fertilizer and its use greatly aids in inoculation.

Seed late enough in September to avoid injury by nematodes, or early enough in October to insure a good stand and growth before winter. Turn the crop under as a green manure 2 weeks before planting corn and 3 weeks before planting cotton.

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WINTER LEGUMES FOR GREEN MANURE IN THE COTTON BELT

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Contents

THE use of winter legumes for green manure in the Cotton Belt has greatly increased in recent years, largely as a result of demonstrations by the State and Federal experiment stations and of practical experience of farmers. Research has demonstrated the value of this practice and the best crops for the purpose.

By "legume" is meant a plant that bears pods like the pea or the bean. These pods are one-celled and usually split in two pieces.

By "winter legume" is meant a legume that has the ability to survive winter temperatures ranging from 60° to 15° F. or lower and that makes more or less growth during this period.

The term "green manure," used in a strict sense, means a crop turned into the soil green or in an immature state for the purpose of soil improvement. A free use of the word commonly denotes any crop material left on the surface or turned into the soil, whether in a green

or in a dry state. A crop that is grown to be left on the surface rather than turned into the soil is usually called a cover crop, but this term is used more or less interchangeably with green manure.

LEGUMES NOW COMMONLY USED

Eight winter legumes are now more or less commonly used for green manure in the Southern States. These are hairy vetch, smooth vetch, Austrian Winter pea, crimson clover, bur-clover, sourclover, Willamette vetch (a variety of common vetch), and blue lupine.

Sourclover has proved adapted to the region that includes California, Arizona, the Delta area of Louisiana and adjoining States, and the blacklands of Alabama and Mississippi. Bur-clover and Willamette vetch are most extensively used in the Mississippi Delta section but can be grown throughout the South, except on the very sandy lands. Austrian Winter pea and smooth and hairy vetches seem to be universally adapted and are the crops most commonly used. Lupines are grown most extensively in northern Florida, southern Georgia, and southern Alabama but are adapted westward to Texas.

Estimates of the acreage of winter legumes used for green manure in the Cotton Belt have been made from the quantity of seed known to have been shipped into the several States, from figures compiled in a few States from reports of county agents, and from such other sources as were available. These indicate about 250,000 as the total acreage of winter legumes planted in the Cotton Belt in 1929 and about 4,000,000 in 1945. The total acreage planted for green manure would be much above these figures, as large quantities of rye and other cereals are used each year for this purpose.

VALUE OF GREEN MANURES

Among the reasons commonly advanced for the use of green-manure crops, some are based on obvious facts, but others are less apparent. In regions where soils erode badly a growing crop on the land during the season of heavy rainfall will prevent much washing. It is well known that soils containing a high percentage of organic matter will wash less than those in which it is low. Thus a green-manure crop will prevent much erosion both during the period of its growth and for the time that it increases the organic content of the soil.

The addition of organic matter usually improves the physical condition of the soil. This is noticeable in its increased moisture-holding capacity and in the ease with which it can be worked when being plowed or disked.

In addition to improving the physical condition of the soil and preventing washing, a winter green-manure crop prevents leaching of plant food during the winter season. When there is no growing crop on the land the plant-food elements that become available through decomposition or otherwise are lost. A growing crop takes up these elements, and they are again made available when it is turned into the soil. In this way a green-manure crop conserves fertilizer. It not only takes up the plant food that otherwise would leach from the soil but also adds nitrogen, which it takes directly from the air through the work of bacteria on its roots.

A fertile soil has a large number of micro-organisms. In order that these may flourish, organic matter must be supplied. Organic matter also has an effect on the mineral elements of the soil and aids in making them available as plant food.

It has long been recognized that legumes are beneficial to nonlegumes in the rotation. Nonlegumes in continuous culture give smaller yields than are obtained from those in rotation with legumes. This increase is due in part to the nitrogen that the legume takes from the air. In addition, other unexplained factors that persist after the fertilizing material of the plant has disappeared appear to have a beneficial effect on nonlegumes.

The net results accruing from the use of winter legumes are increased yield of the crop that immediately follows and lessened but noticeable increases in succeeding crops for several years.

INOCULATION

Under Cotton Belt conditions all winter legumes need to be inoculated with nitrogen-fixing bacteria. This can be accomplished by the use of commercially available pure cultures, directions for which will be found on the package. Inoculation can be induced also by the use of soil from a field that has recently grown the crop it is desired to inoculate.

When soil is used it can be mixed with the seed at the rate of half a bushel or more per acre and be drilled with a three-row drill or with a "knocker" fertilizer distributor. The soil should be dried and sifted to make it run freely, or it can be applied broadcast at the rate of 1,000 pounds per acre and be worked into the soil ahead of seeding. Many farmers think it is good insurance to use both the commercial culture and soil.

One of the most essential things in inducing inoculation and good subsequent growth of winter legumes has to do with the use of fertilizers. Commercial fertilizer, unless it is basic slag, should not come in contact with inoculated seed, as it may injure the inoculating organism. A general application of fertilizer, however, preceding or at the time of seeding, is essential to success.

If the summer crop preceding the winter legume has been well fertilized, the quantity applied to the winter-legume crop can be greatly reduced or in some cases entirely omitted.

When the winter legume is to be planted on lands where it has not grown previously and it follows a summer crop that has been only lightly fertilized, the use of superphosphate will help the inoculation.

Barnyard manure is very effective in inducing inoculation and should be used whenever available.

FERTILIZERS

The successful growing of a green-manure crop on the poorer lands of the South requires the use of commercial fertilizer. Of the common fertilizer constituents phosphoric acid is usually the most needed. On the poorer lands, however, the addition of nitrogen will help materially. This should be used until a winter-legume green-manure crop has been grown successfully. The fertilizer should be applied in the fall just prior to seeding the green-manure crop or at the same time.

The quantity of fertilizer to be used varies with soil and cropping conditions. When the summer crop preceding the winter legume is heavily fertilized, little if any fertilizer will be needed on the winter legume. If the soil is poor and the summer application of fertilizer is light, it is advisable to use 200 pounds or more of superphosphate, or 300 of basic slag and 50 of sodium nitrate or ammonium sulfate or an equivalent nitrate fertilizer. When growing a winter legume for the first time on land that has been only moderately fertilized it is advisable to use as much as 400 pounds of superphosphate or 600 of basic slag per acre and 100 of a nitrate fertilizer.

Lime, used occasionally at the rate of 1 to 2 tons per acre in addition to the fertilizers mentioned, sometimes increases the yields.

PREPARATION OF THE SEEDBED

The largest acreage of winter legumes follows cotton, in which case little or no preparation of the soil is necessary. This is also true following cowpeas, soybeans, or Spanish peanuts. Under such conditions the seed is sown broadcast and disked in, provided the previous crop has been harvested sufficiently early. A crop of tobacco or melons also may be followed by winter legumes, the same method being used. If for any reason the land needs flat breaking, the preparation is more expensive in time and labor.

On clayey soils where there is considerable weed growth or the soil is packed hard, plowing or heavy disking is essential to a good seedbed. In the case of field peas and other crops that have large seeds there is little danger of covering the seed too deep. For best results with crops that have small seeds, however, as crimson clover, it is necessary to work the soil down into a firm condition before seeding.

SEEDING

The best time to seed varies with latitude and seasonal conditions. In general, seed if possible during the last half of September in the northern part of the Cotton Belt and early in October in the southern part. Early seeding is desirable for the greatest fall growth, but where nematodes are numerous early seedings may be seriously damaged. Seedings made about the first of October usually escape with but little nematode injury. In severe winters, however, seedings made as late as the first of December usually result in poor stands because of winter-killing, and little growth will be made by the time the crop should be turned down for corn or cotton. Studies at the Alabama Agricultural Experiment Station show that winter legumes planted on October 1 made twice the yield by April 1 of the next year as those planted on November 1.

In regions where peanuts are grown it is common practice before harvesting the crop to seed blue lupines. When handled in this way, the lupine seed will be covered in the harvesting operations, thus assuring early growth and heavy green-manure yields.

The quantity of seed needed to give a good stand has been reasonably well determined by experimental work. Local variations in the soil, preparation of the seedbed, and other factors influence the rate of

seeding, but in general the range of variation is not great. The quantity of seed considered advisable under average Cotton Belt conditions is shown in the following list. Farther north or where winterkilling and other factors tend to reduce the stand more seed is recommended. Drilling takes less seed than broadcasting, and thoroughly prepared land requires less than land that is rough and poorly prepared. Under favorable conditions the least quantity of seed indicated can be used, but under less favorable conditions the quantity should be increased accordingly.

QUANTITY OF SEED TO USE PER ACRE

Austrian Winter pea (*Pisum arvense*)	pounds	30–40
Bard vetch (*Vicia monantha*)	do	40–50
Bigflower vetch (*Vicia grandiflora*)	do	35–40
Black medic (*Medicago lupulina*)	do	10–15
Blue lupine (*Lupinus hirsutus*)	do	60–80
California bur-clover (*Medicago hispida*)	do	15–20
Common vetch (Willamette and Oregon) (*Vicia sativa*)	do	40–50
Crimson clover (*Trifolium incarnatum*)	do	15–20
Fenugreek (*Trigonella foenum-graecum*)	do	20–30
Hairy vetch (*Vicia villosa*)	do	20–30
Horsebean (*Vicia faba*)	do	60–90
Hungarian vetch (*Vicia pannonica*)	do	40–50
Manganese bur-clover (Southern bur-clover var.)	bushels	5–6
Monantha (oneflower) vetch (*Vicia articulata*)	pounds	30–40
Narrowleaf lupine (*Lupinus angustifolius*)	do	60–90
Narrowleaf vetch (*Vicia angustifolia*)	do	20–30
Persian clover (*Trifolium resupinatum*)	do	5–7
Purple vetch (*Vicia atropurpurea*)	do	40–50
Rose clover (*Trifolium hirtum*)	do	15–20
Rough pea (*Lathyrus hirsutus*)	do	50–60
Serradella (*Ornithopus sativus*)	do	15–20
Smooth vetch (*Vicia villosa* var.)	do	20–30
Sourclover (*Melilotus indica*)	do	15–20
Southern bur-clover (*Medicago arabica*) (unhulled)	bushels	5–6
Tangier pea (*Lathyrus tingitanus*)	pounds	60–70
Tifton bur-clover (*Medicago rigidula*)	bushels	4–5
White lupine (*Lupinus albus*)	pounds	90–110
Woollypod vetch (*Vicia dasycarpa*)	do	25–35
Yellow lupine (*Lupinus luteus*)	do	60–80

The seed may be sown broadcast or with a drill in cotton middles. If broadcast, it may be covered with a one-horse plow or cultivator or with a two-horse cultivator that straddles the row and has disks or plows that do a good job of covering. If drilled, the three-row one-horse drill serves the purpose, but the middle hole may be closed, because the crop does not grow well in the center of the row, especially where it is low. For vetch the sorghum plate may be used, but winter peas need a larger plate. Some farmers go twice to the row with a one-row drill or with a fertilizer distributor that sows a mixture of seed, soil, and basic slag. Complete fertilizer is not mixed in this way, because of the danger of killing the nitrogen-fixing bacteria.

To avoid injury to cotton, the drilling should be done immediately after a picking. In the lower part of the Cotton Belt the cotton is picked out before the winter legumes are planted. Where conditions permit the use of larger drills, they save much time in planting.

Short and narrow plows on the one-horse drills make only a small furrow, but even this should be filled with a smoothing attachment,

such as a scratcher, chains, or a small chain harrow. This is particularly necessary for vetch because the young plants flatten out on the ground and the first heavy rain washes the dirt and sand in on them. The danger is greater on sandy soils.

Drilling properly done gives a larger yield of green manure than broadcasting, just as it does with small grains. There is also less "heaving" of plants in freezing-thawing weather on clay soils.

TURNING-UNDER

When should a green-manure crop be plowed under for a spring-planted crop? This question can be answered only in a general way. If it is done too early it will have too little fertilizer value. If it is done too late the heavy growth will be difficult to turn under and cover properly. Moreover, evaporation of moisture through the leaves of the plants may have pumped the moisture from the soil, leaving it hard and dry. Also, if the crop is either hairy or smooth vetch there is danger of injury from vetch worms (same as corn earworms) after the pods begin to form.

When the weight of green vetch is 12 pounds per 10-foot square, the nitrogen in it, calculated to an acre basis, is equivalent to about 300 pounds of nitrate of soda. For Austrian Winter peas 14 pounds will have nearly the same nitrogen equivalent. This is sufficient for a good crop of corn, and ordinarily it should be plowed in without further waiting. To delay turning beyond this point in order to get 50 to 100 percent more nitrogen means running risks of dry weather, of unwieldly growth, of greater difficulties in getting stands of corn, and of possible injury from vetch worms. In their zeal to get the maximum quantity of nitrogen, many farmers wait too long and run into difficulties they do not foresee.

When the growth is at the stage mentioned, it can be turned under with an ordinary two-horse plow with a 12-inch rolling colter attached. If the growth is heavy, larger plows and more power will be needed. The three-horse sulky plow with rolling colter is an excellent implement for the purpose. Tractor plows, whether of disk or moldboard type, will do the job.

The rate of decomposition of vegetable matter in the soil varies with changes in temperature and moisture. Moreover, one must take into consideration the stage of maturity of the green-manure crop. An immature crop decomposes more rapidly than a mature one, and allowance for this must be made. Experimental work has indicated that a green succulent winter-legume crop should be turned down about 2 weeks before planting corn and 3 weeks before planting cotton. In the case of tree crops the time of active growth of the tree can perhaps be used as a good guide for turning down or otherwise disposing of the green-manure crop. Decomposition should take place just preceding and during active tree growth. Under average spring conditions a succulent green-manure crop turned into the soil decomposes and practically disappears in 6 to 8 weeks. One that is mature decomposes somewhat more slowly. When the crop is worked into the soil lightly or is left on the surface as a mulch the period of decomposition is extended accordingly and erosion will be greatly reduced.

PREPARING LAND FOR SUBSEQUENT CROPS

Most of the winter-legume land is broken flat in spring and harrowed soon after. Then, after a wait of about 2 weeks, it is listed and corn is planted in the water furrows, though sometimes the land is leveled before planting. Sometimes it is "hard-bedded," which means that two furrows are thrown together at intervals of 4 feet, or whatever the width of row happens to be, then the middle ridges are plowed out with a turnplow, and corn is planted immediately in the water furrow. This method is better adapted to sandy lands than to clay. It has as one advantage that corn can be planted without waiting for the legume to decay. Whether in the long run it is advisable to do so, however, it still an open question.

In preparing winter-legume land for cotton it should first be flat-broken. After a wait of 3 weeks or thereabout, low beds should be prepared and the cotton planted in the usual way.

VOLUNTEERING A WINTER LEGUME

Winter legumes that can be satisfactorily volunteered are the least expensive. These can be divided into two classes: (1) Early-maturing, hard-seeded varieties, which set seed before time to plant a succeeding crop; and (2) late-maturing varieties with hard seeds, which do not allow a full season for a succeeding crop. In the late-maturing varieties an occasional seed crop will insure volunteering for 4 or 5 years. In the early-maturing crop an annual supply of seed would be available. No winter legume now in use matures early enough to be out of the way for cotton or early planted corn. In fields planted to these crops a hard-seeded winter legume should be allowed to mature occasionally.

Bur-clover is the one legume that is now being handled successfully in this manner on a commercial scale. A common practice in the Mississippi Delta section is to allow the bur-clover to mature seed one year in five and to follow it after that with late-planted corn. In this way enough bur-clover seed is assured for volunteering the next 4 years. It is also possible to leave strips of the bur-clover undisturbed at the time of planting the summer crop, with the idea of cultivating or turning down these strips after the bur-clover seed has matured, and in this manner provide seed for the succeeding volunteer crop.

Dixie crimson clover, a new hard-seeded strain, can be volunteered satisfactorily with proper management. It can be used throughout the crimson clover area in any way that ordinary crimson clover is used. Its volunteering habit is its distinguishing characteristic.

Bigflower vetch is an excellent volunteering winter legume that, once established, will persist through a long term of years. It matures seed early and regularly, but an occasional crop should be allowed to come to full maturity in order to insure continuous full volunteer stands.

Narrowleaf vetch matures seed early and volunteers readily in waste places throughout the South. It can be successfully grown in orchards and other places where considerable organic matter has been allowed

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to accumulate. Its use should be extended. Regularly cultivated lands low in organic matter, however, are poorly adapted to narrow-leaf vetch.

Hairy vetch under favorable conditions will mature enough seed to volunteer. It matures comparatively late, however, and is liable to damage by the corn earworm. For these reasons, when the vetch is allowed to stand late to produce seed the crop is uncertain and damage to following crops is possible.

Other volunteering legumes that make less winter growth but may serve well under some conditions are rough pea, black medic, rose clover, and Persian clover. All have a high percentage of hard seed that will carry over in the soil for several years.

YIELDS OF GREEN MANURE

The yield of any winter green-manure crop will vary with seasons and with different soils and other local conditions. This is especially true when it must be turned down early in order to be out of the way for a succeeding summer crop. This fact should be given first consideration in determining the time of planting and the crop to use.

TABLE 1.—*Average annual yields, in pounds per acre, of hairy vetch, monantha vetch, Austrian Winter pea, and rye*

Place	Length of experiment	Growing period	Yield per acre			
			Hairy vetch	Monantha vetch	Austrian Winter pea	Rye
	Years		*Lb.*	*Lb.*	*Lb.*	*Lb.*
Tifton, Ga.	17	Oct. 15 to Mar. 1	12, 814	16, 106	11, 910	5, 729
		Oct. 15 to Mar. 15	17, 420	22, 316	14, 433	7, 623
Gainesville, Fla.	2	Oct. 9 to Mar. 8	4, 488	5, 838	5, 715	------
Auburn, Ala.	3	Sept. 30 to Mar. 30	2, 581	5, 635	4, 728	------
Clemson, S. C.	5	Sept. 10 to Mar. 15	9, 928	17, 198	9, 209	------
Stoneville, Miss.	7	Oct. 10 to Mar. 28	17, 970	------	13, 863	------
St. Joseph, La.	12	Oct. 9 to Apr. 1	17, 394	------	15, 261	------

The green weight of hairy and monantha vetches and of Austrian Winter pea are given in table 1, as grown in connection with experimental work in Georgia, Alabama, South Carolina, Mississippi, Louisiana, and Florida.

Crops planted on two dates in fall but harvested on the same date early the next spring are reported by the Alabama Agricultural Experiment Station to have yielded in air-dry weight over a 5-year period as follows: Austrian Winter peas planted October 1, 3,317 pounds; November 1, 2,418; hairy vetch planted October 1, 3,271 pounds; November 1, 2,476. The green weight would be about five times the dry. Louisiana reports yields in experimental plantings at Baton Rouge on Oliver silt loam ranging from 3½ to 6½ tons green weight per acre

for both Austrian Winter peas and hairy vetch; and in the delta of northeastern Louisiana, several times as much.

Yields of Austrian Winter peas and hairy vetch in pecan groves in Florida ranged from 10,000 to 20,000 pounds green weight. The North Florida Agricultural Experiment Station, at Quincy, reports a 3-year average yield of blue lupines of more than 25,000 pounds green weight per acre by March 22, and similar yields have been obtained by commercial growers. Other general data available indicate that a wide range in yield may be expected.

WHAT CROPS TO PLANT AFTER WINTER LEGUMES

Corn is the principal crop to plant after winter legumes and is likely to remain so, although in the southern part of the Cotton Belt much cotton is thus planted. Corn can be planted within wider limits of time than cotton, and this gives a longer period within which to turn under the legume. Cotton land is usually prepared early, much of it before the legume is large enough to turn under. If, however, the art of getting a large early growth of the legume is learned, there will be time to prepare and plant part of the cotton crop thereafter.

Where cotton and corn are rotated it is easier to plant after cotton than after corn, which means that corn will naturally follow the legume. The presence of summer legumes in the corn and the frequent knocking down of the cornstalks across the rows by storms make it difficult to interplant the legume between the rows, therefore the next year's cotton is not preceded by a winter legume. Where corn is harvested for silage, however, the conditions are ideal for planting winter legumes, and cotton may follow thereafter.

Other crops that can be planted in May or June, including sweetpotatoes, sorghum, cowpeas, and soybeans, may follow winter legumes.

INCREASED YIELDS OF CORN AND COTTON FROM USE OF GREEN MANURE

Increased yields of corn and cotton have resulted from the use of a green-manure crop whenever a good yield of that crop has been obtained and handled in season. The general experience of farmers as well as experimental results indicate the value of this practice. At Tifton, Ga., several legumes were used in comparison with Abruzzi rye and no legume, with the results given in table 2. The average yield on plots using a winter-legume green manure was consistently higher than on plots using rye or no legume. The difference in yield was sufficiently great to justify considerable expense on the legume.

The experiment station at Clemson, S. C., reports yields comparable with those obtained in Georgia. The average yield of corn per acre for the two years when a side dressing of 100 pounds per acre of sulfate of ammonia was used was 13.8 bushels on the rye plots and 27.3 and 25.7 bushels for Austrian Winter pea and vetch plots, respectively. In the case of the plots receiving no side dressing, the yield of corn on the rye plot was 5.3 bushels and on the Austrian

Winter pea and vetch plots 25.3 and 18.5 bushels, respectively. In this experiment the winter crop received 200 pounds of superphosphate and 50 pounds of muriate of potash.

TABLE 2.—*Average yields of cotton and corn at Tifton, Ga., following winter green-manure crops*[1] *over a 16-year period*

Green-manure crop	Acre yield, with complete and incomplete fertilizer			
	Corn		Seed cotton	
	N–P–K 0–10–4[2]	N–P–K 2–10–4[2]	N–P–K 0–9–5[2]	N–P–K 3–9–5[2]
	Bushels	*Bushels*	*Pounds*	*Pounds*
Austrian Winter pea	48. 2	46. 6	1, 318	1, 303
Hairy vetch	46. 2	48. 1	1, 238	1, 342
Monantha vetch	45. 6	47. 7	1, 283	1, 425
Abruzzi rye	28. 7	32. 4	1, 067	1, 221
No green manure	28. 1	31. 6	719	961

[1] Green-manure crops were sown Oct. 1 and turned under Mar. 1 for cotton and Mar. 15 for corn. Fertilizer used, 500 pounds per acre for corn and 1,000 for cotton. No fertilizer was used with the green-manure crop.

[2] Percentages, respectively, of nitrogen (N), phosphorus (P), and potassium (K).

At the experiment station at Auburn, Ala., the increased yield of corn due to plowing down vetch for a 5-year period was 15.5 bushels per acre when the vetch was turned on March 22; 22.2 when turned on April 5; and 22.4 when turned on April 15. For cotton the increase was 593 pounds of seed cotton per acre when the vetch was turned on March 25; 534 when turned on April 5; and 460 when turned on April 15.

In a survey of farms using winter legumes in South Carolina, Georgia, and Alabama the writers obtained estimates from farmers of the increased yields of corn and cotton for a 5-year period following the use of these legumes. The survey covered 353 instances of corn following winter legumes and embraced 4,145 acres of that crop. The average increase in yield of corn for this acreage was 14 bushels per acre. Also, in 147 instances of cotton after winter legumes, covering 1,877 acres, the average increase due to the use of these legumes was 100 pounds of lint cotton per acre.

HOW MANY ACRES OF WINTER LEGUMES PER MULE?

The average farmer who has had experience with winter legumes in the Southeastern States says that 5 acres to the mule is practicable, but he usually falls below this figure in his own practice. It is physically possible, however, to do much better than this by using plenty of seed, planting early, and using fertilizers and the legume that makes the best early growth. The good early growth may then be such that turning under can be commenced a week or 10 days in advance of the

usual time. The Alabama Agricultural Experiment Station has already been quoted to the effect that plantings of winter legumes on October 1 have made twice the growth by April 1 of the next year as those planted November 1; also, the average yield of Austrian Winter peas on April 1 from plantings made October 1 for a 5-year period was 9,136 pounds green weight per acre, whereas hairy vetch gave 6,546 pounds for the same period of planting and harvesting.

The season can be further extended by using other crops. Late in May or the first of June a few acres of bur-clover or crimson clover can be plowed under after the former is ripe and the latter harvested for seed and planted to some late crop. If the soil is suited to bur-clover that legume will perpetuate itself in a 2-year rotation of late-planted corn one year and cotton the next. Some seed of the bur-clover will mature before the crop is turned under, and the "hard" seed will live over in the soil 2 years or more.

Instead, therefore, of 5 acres to the mule, 3 or 4 more can be added early in the season and 2 or 3 more late in the season, making a total of 10 or 12 acres to the mule. Livestock men who keep legumes pastured may have a still larger acreage, and those who have tractors can handle a large percentage of land in winter legumes.

On large areas in the South neither crimson clover nor bur-clover do well, but there are possibilities with hop clover and Carolina clover.

SEED PRODUCTION IN THE SOUTH

Wherever crimson clover grows well the seed can be saved by every farmer. Methods of doing this will be found in United States Department of Agriculture Leaflet 160.

The production of Austrian Winter pea seed and hairy vetch seed is irregular and uncertain, and yields are small even when obtained. Corn earworms sometimes attack hairy and smooth vetches and defoliate them. Farther south there is more danger from these worms. If production is attempted, however, watch should be kept for them every day after pods begin to form. At the first sign of worms the crop should be plowed down as a fertilizer. If they do not appear, the crop may be kept for seed.

In Arkansas, Oklahoma, northern Mississippi, Alabama, and the Piedmont of North Carolina, hairy vetch seed has been grown more or less successfully. In recent years, however, the vetch weevil has greatly damaged the seed crop in many places, making it less profitable. Seed of monantha and Willamette vetch has been harvested in northern Alabama. Weather and insect damage, however, make the crop uncertain and the total production small.

RESIDUAL EFFECT OF WINTER LEGUMES

Experimental data indicate that the residual effect of winter legumes continues for several years. At the Central Experimental Farm, Ottawa, Canada, a crop of clover gave an increase in corn, oats, potatoes, carrots, and sugar beets planted in successive years. In the latter year the potato increase was 20 bushels per acre, the carrots 11.16 tons per acre, and the sugar beets 13.7 tons.

At Jackson, Tenn., a well-established stand of sericea lespedeza was turned under preceding the planting of corn. The corn yield was more than doubled the first year and the residual effect of the lespedeza continued to influence the yields through a 10-year period. If the grower merely comes out financially even on the first crop after winter legumes, he will still find their use advantageous because of their influence on the next year's crop (fig. 1).

FIGURE 1.—Corn planting in Georgia, showing effect of winter legumes. Corn on right followed vetch; that on left not preceded by any legume.

INSECTS AND NEMATODES

In the Cotton Belt little difficulty with insects has been found in growing winter legumes except in cases where the crop has been allowed to stand late in spring. Serious damage to hairy vetch by the corn earworm has resulted when the crop was allowed to stand late in the hope of getting a seed crop. No method of complete control has been discovered for the vetch weevil, which in the last few years has done serious damage to the vetch seed crop. Dusting with DDT has given partial control.

Aphids also may do serious damage to winter green-manure crops that are allowed to continue growth late in spring. The green-manure crop is turned under for cotton or corn so early, however, that usually little, if any, damage is to be expected. In the northern part of the Cotton Belt aphid damage may be expected after April 15; in the southern part, the last of March or early in April. When aphids appear in abundance the green-manure crop should be turned under or disked down at once.

Experimental work of the Alabama Agricultural Experiment Station indicates that the damage to the corn crop by the southern corn

rootworm is increased when the corn follows a green-manure crop. Little or no damage, however, has resulted from plantings made on April 30 and later. In latitudes farther north, to avoid damage by this insect, the date of planting will be somewhat later. This matter is discussed in Farmers' Bulletin 950, The Southern Corn Rootworm and Farm Practices to Control It.

All the winter legumes commonly used in the Cotton Belt are subject to attack by nematodes, and under favorable conditions serious damage may result. So far as observations have been made, all other winter legumes used in experimental planting are hosts to nematodes, which are most active during warm weather. Serious damage to the green-manure crop can be avoided by delaying the planting until the last of September or early in October, thus bringing the growing season entirely into the cooler part of the year. This has been indicated under the heading "Seeding."

LEGUMES ADAPTED TO THE COTTON BELT

HAIRY VETCH

Hairy vetch is one of the oldest and most commonly used green-manure crops of the Cotton Belt. Being one of the most winter-hardy of the vetches, it seldom suffers any winter injury. It is usually considered a winter annual, although when sown in spring it often carries over into the second year as a biennial. The stems are comparatively weak or viny, ascending only with support. The plant has a higher minimum, or zero, growing point than other vetches that are less winter-hardy, so that in seasons with a low mean temperature its growth may be less than that of others with a lower zero

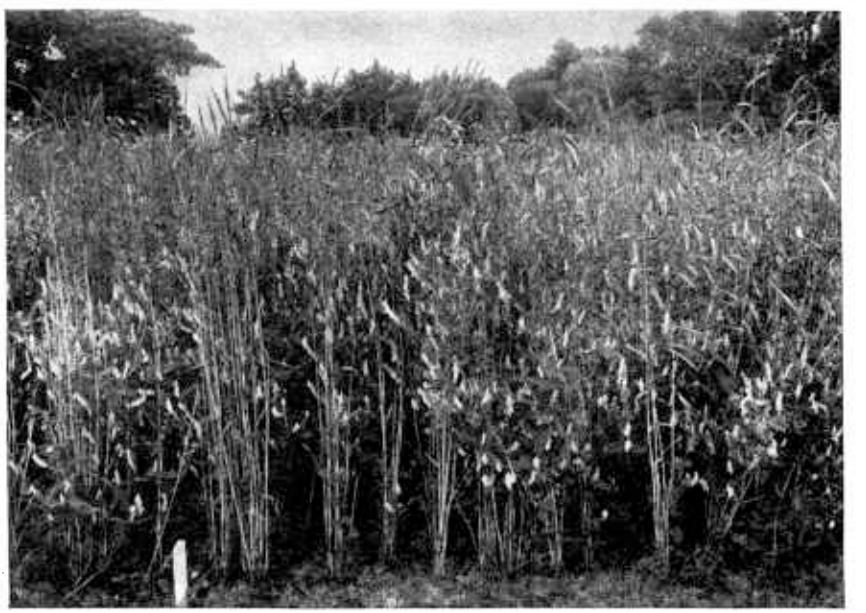


FIGURE 2.—Hairy vetch, showing the general habit of growth in mixture with rye.

growing point. In mild winters, however, or in winters having a high mean temperature, it may yield as heavily as any less hardy variety.

The seed of hairy vetch cannot be distinguished from that of smooth vetch, and the two are being sold under the name hairy vetch. In growth, however, the varieties are distinct, the hairy vetch having long hairs on the stems and leaves, whereas the smooth vetch has fewer and less conspicuous hairs. A tufted growth at the ends of the stems of hairy vetch is also characteristic. The flowers of hairy vetch are a little larger than those of smooth vetch and less reddish purple (fig. 2).

SMOOTH VETCH

In general, smooth vetch is like hairy vetch. It is a variety of the same species but differs in lacking the tufted growth at the ends of the stems and in having fewer hairs, or less pubescence, on stems and leaves. The flowers are more reddish purple and somewhat smaller. Smooth vetch is winter-hardy in the Southern States and as far north as Washington, D. C., but it cannot be grown so far north as hairy vetch. It has a lower zero growing point than hairy vetch and for this reason can be expected to make winter growth in seasons and at times too cool for hairy vetch. In experimental work smooth vetch has been one of the best winter legumes under southern conditions. In commercial plantings in the South it has made somewhat better growth than hairy vetch and is to be preferred to that variety.

WOOLLYPOD VETCH

Woollypod vetch is of proved value for Cotton Belt conditions and has been used in experimental plantings for many years. It is not now found in the trade, though it was once grown commercially in small quantity.

FIGURE 3.—Woollypod vetch in experimental planting, showing general habit of growth.

In general appearance and in cultural requirements woollypod is very much like smooth vetch. In fact, when growing in the field the two can be readily mistaken one for the other. The flower of woollypod is a little smaller and a little deeper red than that of smooth vetch. In size and color the flowers of smooth vetch are halfway between those of hairy and woollypod.

Unlike that of smooth vetch, the seed of woollypod can be readily distinguished from that of hairy vetch. It is oval instead of nearly spherical, as in hairy vetch, and has a groove along the dividing line of the seed scar, which is not present in either hairy or smooth vetch. The seed of woollypod is usually a little larger than that of either hairy or smooth vetch, but this difference cannot always be depended upon.

The minimum temperature at which woollypod vetch will make growth is lower than that for hairy vetch, and in this respect it is more like smooth vetch. It is a vetch that can be widely used in the Cotton Belt (fig. 3).

MONANTHA VETCH

In general habit of growth monantha (oneflower) vetch is similar to other vetches. It has finer stems and leaves than hairy vetch and is one of the earliest maturing of the vetches. The minimum temperature at which it will make growth is lower than that for hairy or smooth vetch or Austrian Winter pea, and it is one of the best winter legumes for making growth during winter or in periods with a low mean temperature. In point of winter hardiness it is not to be compared with hairy vetch, Austrian Winter pea, or even smooth or woollypod vetch. It is comparable to common vetch, however, and will survive most winters throughout the Cotton Belt except in the extreme northern part. Two varieties selected for vigor and winter hardiness were put out by the Alabama Experiment Station under the names Lafayette and Monalla.

NARROWLEAF VETCH

Found as a weed by the roadside and in waste places throughout the Cotton Belt, narrowleaf vetch is like most other vetches and is closely related to common vetch. Its season of maturity is early, and for this reason it ripens seed regularly under southern conditions. The percentage of hard seed in this species is high, and this carries over in the soil, giving a volunteer crop from year to year. When planted under field conditions and given ordinary cultural attention it has seldom succeeded. It seems to require some protection, and a possible essential to its growth is the accumulated organic matter supplied by weeds or grass, with which it commonly volunteers.

Narrowleaf vetch can be recommended for growing in mixture with Bermuda grass or Johnson grass for hay or for volunteering in orchards as a winter crop where a heavy grass growth is allowed to accumulate during the latter part of the summer. It will make growth under about the same temperature conditions as bur-clover or hairy vetch. Strains naturalized in the South are often referred to as Augusta vetch.

COMMON VETCH

Common vetch is a semiviny plant having slightly larger leaves and stems than hairy vetch. Less winter-hardy than that species, it sometimes winterkills under Cotton Belt conditions. The minimum temperature at which it will make growth is lower than that for hairy vetch or Austrian Winter pea, and for this reason it is to be preferred where it is winter-hardy and adapted. This vetch is being used in commercial plantings in the lower Mississippi Delta section, where the hardier varieties have given good results. With proper cultural treatment, it seems probable that it can be grown successfully over a much wider area (fig. 4).

FIGURE 4.—Stem and seed pods of common vetch.

Willamette vetch, a variety selected for winter hardiness, is superior to common vetch for general use. Other varieties imported from Europe usually have lacked winter hardiness.

HUNGARIAN VETCH

Hungarian vetch, a comparatively new species, has become commercially established in western Oregon. Experimental plantings in the Cotton Belt have indicated that it is not so well adapted to sandy lands as other vetches, but on heavy lands it has given good results. It is entirely winter-hardy throughout the Cotton Belt and as far north as Washington, D. C. The minimum temperature at which it will make growth is about the same as that for bur-clover and hairy vetch. Results up to the present time suggest that it may have value for use on the heavier lands of the northern part of the Cotton Belt and in the Mississippi Delta section (fig. 5).

PURPLE VETCH

In general appearance purple vetch is similar to hairy vetch except in winter hardiness. Being one of the least winter-hardy of the vetches, it has usually winterkilled in experimental plantings at sta-

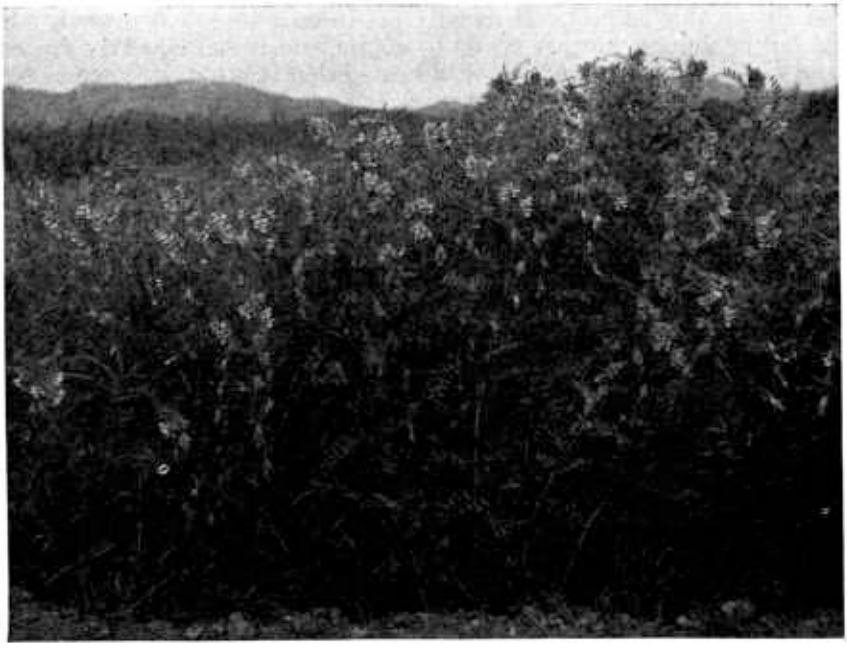


FIGURE 5.—Hungarian vetch in western Oregon, showing general habit of growth.

tions in the Cotton Belt. The zero growing point, or minimum temperature at which it will make growth, is lower than for Austrian Winter pea, hairy vetch, or smooth vetch. In this respect purple vetch is desirable, but its lack of winter hardiness precludes its general use in the Cotton Belt.

BIGFLOWER VETCH

In general habit of growth, bigflower vetch is like most other vetches. It makes good winter growth and has a high percentage of hard seed. This latter character makes it possible to volunteer stands from year to year for a long period. It is somewhat more winter-hardy than common vetch, but less so than hairy vetch.

BARD VETCH

The general growth habit of bard vetch is similar to that of hairy and common vetches. In experimental plantings at a number of southern stations it has made very little growth, and it does not promise to be of value under Cotton Belt conditions.

HORSEBEAN

Although the horsebean is related to the vetches, it is quite different from most of them in general appearance. It is a coarse, upright-growing plant having large broad leaflets. All the many varieties require more or less the same general climatic and cultural conditions. The minimum temperature at which it will make growth is comparatively low, this plant being comparable to purple and monantha

vetches in this respect. It usually produces a succulent growth late in fall or during warmer spells in winter and is subsequently frozen and killed. Experience has not indicated that it is to be recommended for use as a winter green manure in the Cotton Belt.

AUSTRIAN WINTER PEA

The variety of pea introduced to the trade several years ago under the name "Austrian Winter" seems to be identical with the gray winter variety. It is one of the most winter-hardy varieties of the pea and makes good growth under Cotton Belt conditions. The plants are viny, ascending only with support (fig. 6). It has a low minimum growing

FIGURE 6.—Good growth of Austrian Winter pea in pecan grove, southern Georgia.

point and in this respect is about like smooth and woollypod vetches. It has a greater acreage planting than any other winter legume, with the possible exception of hairy vetch. Commercial seed production has now reached about 50,000 acres.

TANGIER PEA

The general habit of growth of the Tangier pea is similar to that of the common garden sweet pea. In winter hardiness it is similar to monantha vetch, being much less hardy than hairy vetch or Austrian Winter pea. The minimum temperature at which it will make growth is about the same as that of hairy vetch, or slightly lower. A rapidly growing plant at moderate temperatures, it gives a heavy yield of green manure. Experimental plantings suggest that it will make good growth in most seasons in the southern part of the Cotton Belt, but it has not been found superior to monantha vetch and Austrian Winter

pea. As its seed habits are poor and the cost of seed correspondingly high, its use no doubt will be limited.

ROUGH PEA

Rough pea is a weak-stemmed plant similar to vetch or field pea. It makes much less winter growth than most winter cover crops, but can be used where late winter growth will serve. Its high percentage of hard seed insures volunteering. Lateness of maturity, however, makes it necessary to defer the planting of a succeeding summer crop.

BUR-CLOVERS

Two species of bur-clover—southern and Tifton—are grown in the Cotton Belt.

Tifton bur-clover is a recent introduction that has been grown and distributed from the Georgia Coastal Plain Experiment Station, at Tifton, from which place it takes its name. Although it makes a decumbent growth and in general is like the southern bur-clover, it differs in having darker green leaves and lacks the dark-purple spot in the middle of each leaflet. It also is more winter-hardy than the southern bur-clover.

California bur-clover is occasionally sown in the Cotton Belt States, but usually without success, as it is less winter-hardy than either Tifton or southern bur-clover and is often damaged severely by cold weather.

A strain of southern bur-clover known as Manganese has recently received considerable attention. It matures about 2 weeks earlier than other strains and for this reason can be used to advantage where early maturity is essential.

The minimum temperature at which the bur-clovers will make growth is somewhat higher than that of either smooth or woollypod vetch, but about the same as that of hairy vetch.

BLACK MEDIC

Black medic is closely related to the bur-clovers. It makes somewhat slower winter growth than field peas or the vetches, but in the lower South it will make a good winter cover and can be used in situations where a winter crop can be allowed to stand late and mature seed, at least every few years, in order to insure volunteering. When handled in this way, black medic can be readily volunteered and the cost of seeding reduced accordingly. In planting black medic in the South it is essential to have adapted seed. This means that the seed should be from stands that have volunteered in the South and produced a good growth. Inoculation is advisable on land that has not previously grown black medic or bur-clover.

CRIMSON CLOVER

Crimson clover is recognized as a good winter legume, but it is sometimes difficult to get a good stand. This uncertainty has prevented a much wider use of the crop for green-manuring purposes.

It is best adapted to the more northern part of the Cotton Belt and is used most extensively from northern Georgia and northern Alabama northward to New Jersey. It will not make growth at as low a temperature as Austrian Winter pea and woollypod and smooth vetches, but at slightly higher temperatures it makes rapid growth (fig. 7).

FIGURE 7.—Good growth of crimson clover about ready to turn down for green manure.

Dixie crimson clover, a widely adapted strain with a high percentage of hard seed, has recently been developed. The hard seed should help insure stands and make possible the volunteering of the crop through a term of years. This variety is especially adapted to the South, and it is in this region that it will be most serviceable.

ROSE CLOVER

Rose clover is a winter annual with much the same habits of growth as bur-clover. It makes less winter growth than the bur-clovers and vetches.

PERSIAN CLOVER

Persian clover is a winter annual. It makes somewhat more winter growth than white clover and matures earlier. Its high hard-seed content and consequent volunteering ability make its use as a volunteering winter cover advisable in sections where it is adapted and where the cover crop can be allowed to remain until late winter or early spring before the ground must be worked for a succeeding crop. Every 4 or 5 years the crop should be allowed to mature seed fully in order to insure a supply for volunteering. The use of phosphate and potash is usually beneficial and is essential on soils of low fertility. The organism that inoculates white and other clovers will inoculate Persian clover, so that artificial inoculation is not essential in places where other clovers succeed.

SOURCLOVER

Sourclover, an upright-growing winter annual, has been used extensively for green manure in the Southwestern States. Its use in the Cotton Belt has been limited to the lower Mississippi Delta area and the blacklands of Mississippi and Alabama. It is not recommended for general use outside of this territory. On other lands of the South it succeeds only with heavy applications of lime and superphosphate.

The minimum temperature at which sourclover will make growth is higher than that for Austrian Winter pea, smooth vetch, and woollypod vetch, and it has about the same temperature-growth requirements as bur-clover. The seed of sourclover usually has been cheap, and as only a small quantity is needed for seeding, the crop can be grown with very little expense.

LUPINES

Lupines have been used in European countries for soil improvement and recently have come into extensive use in the southeastern United States. In Hungary and Germany they are especially valuable for green manure on sandy lands and have been grown extensively for this purpose. The white, yellow, and narrowleaf are the lupines most used.

The narrowleaf lupine, known locally in the South as blue lupine, is the one used commercially. About 200,000 acres were planted to this variety in 1945. It is most extensively grown in southern Georgia and Alabama and northern Florida. Large winter growth and seed-producing ability make it an especially valuable winter green-manure and cover crop for this region (fig. 8).

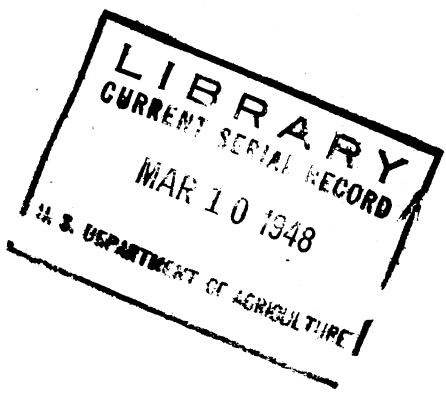
FIGURE 8.—Blue lupines in Florida, showing general habit of growth.

FENUGREEK

Fenugreek has been grown as a winter green-manure crop in California, but never successfully in the Southern States. In experimental plantings it has made little growth and seems to be unsuited to general southern conditions. Further experimental work may demonstrate limited areas to which it may be suited or indicate cultural practices that may make for success. The minimum temperature at which fenugreek will make growth is about the same as that for bur-clover and sourclover, and it is much like these crops in winter hardiness.

SERRADELLA

Serradella is a semiviny plant more or less like the vetches in general habit of growth. It is used for soil improvement on sandy lands in Germany, but has never been grown commercially in the United States. In experimental plantings in the South it has generally failed to make good growth, except in a few cases where the soil was well supplied with accumulated organic matter.



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